

*What is the relationship between caries experience of school children and the frequency of eating between meals? What kinds of items are eaten between meals and how can this be studied? This study endeavors to provide some of the answers and to show how they can be used meaningfully in dental health education.*

## **BETWEEN-MEAL EATING HABITS AND DENTAL CARIES EXPERIENCE IN PRESCHOOL CHILDREN**

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**B**EGINNING with the work of Miller<sup>1</sup> in 1890 and continuing to the present time, much research has been conducted which implicates refined carbohydrate in the etiology of dental caries, but the exact role of refined carbohydrate in the process which produces dental caries has been difficult to define. These years of study which reflect various approaches in the dental and nutritional fields were highlighted at various intervals by several distinct changes in thought. At times, newer concepts have come into direct conflict with those that had become widely accepted just before the appearance of new data. However, as new evidence was revealed most conflicts were resolved and the current concept of the carbohydrate-caries relationship allows sufficient latitude to encompass most of the ideas that appeared to be firmly established at various times in the past. Each has contributed its measure to the evolution of present-day thought regarding the carbohydrate-caries relationship.

It is apparent that another new phase of study is emerging. The general direction of this continuing search for more knowledge about the carbohydrate-caries relationship is guided by two im-

portant concepts currently gaining increasing support from recent studies. In brief, these concepts are:

1. The frequency of eating carbohydrates, especially sugar containing foods, is an important factor in determining cariogenic activity.
2. The consistency of a given foodstuff is a most important factor in determining its cariogenic potential.

It is important to note that these concepts emphasize the importance of the physical character of foods and the number of times consumed rather than the total quantity of sugar or carbohydrate consumed. These concepts are based on significant findings relating to the effect of sugar on the pH within the dental plaque as reported by Stephan,<sup>2</sup> and to oral sugar clearance as reported by Lundqvist.<sup>3</sup> Oral sugar clearance is defined by Lundqvist as the sum of the time periods in one day during which the saliva contains sugar. Frequent eating, then, would tend to increase this total time period.

The study described in this report relates primarily to the first of the concepts—the frequency of eating. More specifically, the study was limited to the frequency of eating certain between-

meal items. Justification for excluding mealtimes from the frequency determination is based on certain assumptions which, from a practical point of view, should not affect the findings. Most people in this country customarily consume three meals each day and the probability, as shown by studies such as that of McDonald and Zita,<sup>4</sup> is very high that each of these meals will include substantial amounts of refined carbohydrate. Therefore, a frequency of three exposures to refined carbohydrate each day was considered to be constant and the observations made were limited to the frequency of eating between meals—especially items of high sugar content or those of a high degree of adhesiveness.

The purposes of the study are threefold:

1. To devise a practical method of determining the frequency of eating between meals and thereby to assess the general between-meal eating patterns of children.
2. To determine what types of between-meal items are most frequently eaten.
3. To determine whether a relationship between the total frequency of eating various between-meal items, composed primarily of refined carbohydrates in various combinations, and caries experience could be demonstrated in a population group.

The West Tennessee region offered a unique opportunity for conducting the study. Each spring the local health departments conduct preschool health conferences which include a physical examination, a dental inspection, and parent and child guidance relating to the health needs of each child. The dental staff of the regional office participates in these conferences and routinely inspects more than 1,000 preschoolers each year. In the spring of 1956, the dental staff included the dietary study described in this report in addition to the routine dental inspections conducted as part of the preschool conferences.

The study group was composed of 783 children and encompassed an age

range of 62-78 months. The mean age was 69.4 months, or approximately five and three-fourth years. Thirteen counties were represented. Twenty-eight per cent of the group lived in very small towns and the other 72 per cent were rural children. In this discussion, rural refers to those children living outside the geographic limits of these communities; 52 per cent were males.

## The Method

In order to achieve the purposes of the study, three basic determinations were made: The types of between-meal items consumed, the number of times during a given time interval such items were consumed, and a quantitative expression of past caries experience.

A list of food items was prepared which was known to represent practically all the types of between-meal items consumed by the children to be studied. About half the items can be classified strictly as confections. The other half was composed primarily of common food items or combinations of various items such as graham crackers, pastries, bread and sweet spreads, or peanut butter. Each parent was questioned about which items in the list the child had eaten and also how many times he had eaten each item during the previous day.

In view of the large number of children in the study group, the 24-hour recall was deemed to be the method of choice. Since the primary objective of the study called for a method of assessing only the general pattern of between-meal eating, it was not intended that the cariogenicity of any given type of food item be determined or that a relationship between specific types of between-meal items and dental caries experiences be established. Confidence in selecting the 24-hour recall was enhanced by the findings of Chalmers-Clayton-Gates, et al.,<sup>5</sup> who reported that a dietary record need consist of only one

day when characterizing the dietary intake of a group if a large number of subjects are included. Therefore, a margin of safety existed. It was obvious that the method selected for this study would not demand the sensitivity required for recording in great detail the total dietary intake of a group.

The caries experience was expressed quantitatively by using the def (decayed, indicated for extraction and filled teeth) determination, an index frequently employed to depict caries experience in the primary dentition. Missing primary molars were added to the total def score, the sum representing the total past caries

experience of the child. Inclusion of the extracted primary molars in the final score appeared justified since the loss of primary molars in this age group can be attributed primarily to caries.

An alternate choice for determining caries experience might have been based on caries incidence rather than on caries prevalence. However, it also appeared that the method need not exhibit a high degree of sensitivity for a gross determination of caries experience beyond the point of demonstrating a trend or pattern.

Figure 1 illustrates the general format of the survey form, the type of face

<b>RECORD OF ITEMS CONSUMED BETWEEN MEALS AND CARIES EXPERIENCE</b>	
<ul style="list-style-type: none"> <li>— CANDIES</li> <li>— GUMS</li> <li>— SOFT DRINKS</li> <li>— FRUIT ADES</li> <li>— KOOLADE</li> <li>— ICE CREAMS</li> <li>— SHERBETS</li> <li>— POPCICLES</li> <li>— PASTERIES</li> <li>— GRAHAM CRACKERS</li> <li>— PUDDINGS, JELLO</li> <li>— CHOCOLATE MILK</li> <li>— COCOA</li> <li>— BREAD &amp; SWEET SPREADS</li> <li>— BREAD &amp; PEANUT BUTTER</li> <li>— DRIED FRUITS</li> <li>— OTHER (SPECIFY) _____</li> <li>_____</li> </ul>	<div style="margin-bottom: 10px;">NAME _____</div> <div style="margin-bottom: 10px;">DATE _____</div> <div style="margin-bottom: 10px;">COMMUNITY _____</div> <div style="margin-bottom: 10px;">BIRTHDATE _____</div> <div style="margin-bottom: 10px;">FLUORIDATED WATER _____</div> <div style="margin-bottom: 10px;">MALE _____ FEMALE _____</div> <div style="margin-bottom: 10px;">RURAL _____ TOWN _____</div>
<div style="text-align: right;">_____ TOTAL FREQUENCY</div>	<div style="margin-bottom: 20px;">           PRIMARY MOLARS EXTRACTED _____         </div> <div>           PERMANENT MOLARS PRESENT _____         </div>
<b>REMARKS</b> <div style="height: 40px; border: 1px solid black;"></div>	

Figure 1—Survey Form

data recorded, and the specific types of between-meal items included.

### Most Popular Between-Meal Items

Of the five most popular between-meal items consumed, four can be classified strictly as commercial confections. In descending order of popularity, these items were gum, candies, soft drinks, and ice cream. The fifth item, more popular than ice cream and more often prepared in the home than the four types mentioned previously, is represented by the pastry group—including items such as cookies, pie, cake, and graham crackers.

Gum was consumed by approximately one out of every three children the day previous to the health conference. This was true of candy to a slightly lesser degree. Approximately one out of every four children consumed soft drinks, a similar ratio applies for items in the pastry category. One out of five consumed ice cream; one out of six, various combinations of bread, crackers, sweet spreads, and peanut butter. The balance of the items—including puddings, chocolate milk, dried fruits, popsicles, and sweetened noncarbonated beverages of various kinds—were much less popular. The exact percentages relating to the selection of various types of between-meal items are shown in Table 1.

The availability of the various types of between-meal items appears to be universal since no substantial differences were detected between subgroups, that is, between male and female and between town and rural children. There appeared to be little difference in the type of between-meal items selected by boys and girls. The largest difference, 6 per cent more boys than girls, occurred in the consumption of soft drinks. Also, relatively small differences were observed in the town and rural children, 7 per cent more town than rural children consumed soft drinks; 11 per cent

**Table 1—Types of Between-Meal Items Consumed, West Tennessee, 1956**

Items	Children Consuming Specified Items	
	Number	Per cent
Gum	297	35.48
Candy	271	32.50
Pastries*	220	26.28
Soft Drinks	218	26.05
Ice Cream	161	19.24
Bread, Crackers†	126	15.05
Others‡	94	11.23

\* Includes items such as cookies, graham crackers, pies and cakes.

† Includes various combinations of bread, crackers, sweet spreads and peanut butter.

‡ Includes puddings, chocolate milk, dried fruits, popsicles and ades of various kinds.

more town than rural children consumed items in the pastry group.

### Frequency and Caries Experience

The average frequency of eating between meals and the average def score for the total children studied were computed to depict the general character of the study group. The average number of between-meal items of high sugar content or high degree of adhesiveness consumed was 1.75 between-meal items per day. A similar average was computed for each subgroup; that is, for boys and girls and for rural and town children. As shown in Table 2, the frequencies for each subgroup were practically the same as the frequency of eating these kinds of snacks between meals for the group as a whole. More specifically, no important differences were shown between the total group of children, the boys, the girls, rural children, or children living in towns.

Computations of the average number of def teeth presented an identical picture. The number of def teeth for the total group studied was 5.88 per child. Again, as was true of the average frequencies of eating such items between

meals, practically no difference was noted between the def average of the total group and that of each of its components.

In addition to characterizing the study group, these determinations serve as an internal check on the basic premise that prompted the study. The averages for the total group of children and the various subgroups should provide the first clue about the existence of a positive relationship between caries experience and the frequency of eating certain cariogenic items between meals. In other words, if the average frequencies of eating between meals in the subgroups were found to be similar, the corresponding average def scores should also be similar. Or, if any of the average frequencies of eating between meals in the subgroups differed, a difference should be observed also in the corresponding def figure. In either instance, such an occurrence would add credence to the existence of a positive relationship between the frequency of eating between meals and caries. As shown in Table 2, the striking similarities between the various frequencies of eating between meals and their corresponding def averages appear to substantiate this belief.

It was hoped that the method devised for this study would be sensitive enough

to detect any definite trend relating to caries experience and the frequency of between-meal eating. More hopefully, would this trend be a positive one and support the thesis that frequent eating is related to caries experience? If so, the bulk of cases in the lowest frequency group should exhibit the least amount of caries. This pattern should shift as the frequency of eating between meals increases until, at the other extreme, the bulk of cases in the highest frequency group should exhibit the greatest amount of caries. A shift from lower to higher caries experience did occur as the frequency of between-meal eating increased and is illustrated in Table 3. The def groups containing the greatest concentration of cases at each frequency level are underlined.

Finally, the data were arranged by frequencies more finely drawn and caries experience was represented by the number of def teeth per child, rather than in def groupings. Originally, as stated earlier, it was believed that the method employed in this study would not be sensitive enough to demonstrate a significant relationship at this level of fineness. However, a direct and consistent relationship, not attributable to chance, was disclosed and is illustrated in Figure 2. The children who reported eating no "sweet" and/or "sticky" between-meal items the day prior to the health conference exhibited a def of 3.3 teeth per child. As the frequency of eating such items between meals increased, a corresponding increase was noted in the number of def teeth per child. The children who reported eating four or more items exhibited a def of 9.8 teeth per child.

## Discussion

Basic research findings, from which the carbohydrate-caries concept has evolved, are of little value from a public health point of view unless they can be

**Table 2—Average Frequencies and def\* Teeth by Total Children and Various Subgroups, West Tennessee, 1956**

Group	Number of Children	Average Frequency	def* Teeth
Males	404	1.77	5.99
Females	379	1.73	5.70
Rural	562†	1.71	5.95
Town	220†	1.87	5.74
Total	783	1.75	5.88

\* Includes extracted primary molars.

† Discrepancy in the sum is due to exclusion of one undetermined case.

**Table 3—Percentage Distribution of Children by Frequency of Between-Meal Eating and Number of def\* Teeth, West Tennessee, 1956**

Frequency Group	Number of Children	Number of def* Teeth				
		0	1-4	5-8	9-12	Over 12
0	129	41.9	28.7	16.3	7.8	5.4
1	235	23.4	32.3	25.5	13.2	5.5
2	211	16.1	27.5	30.3	20.4	5.7
3 or more	208	7.7	13.9	26.0	26.4	26.0

\* Includes extracted primary molars.

translated effectively to the patient and the public. For the most part, literature in both the dental and nutrition fields is void of studies relating to the practical application of basic research findings of this kind. Consequently, little guidance is provided from this source to the health worker who is concerned about the translation of these findings into program content for everyday use.

In spite of this lack, however, considerable effort aimed at eliminating or substantially reducing the consumption of refined carbohydrates has been expended by private practitioners and health workers—particularly in the dental field. For example, 75 per cent of the state dental divisions report activities relating to the reduction of refined carbohydrates as a part of the state dental health program.

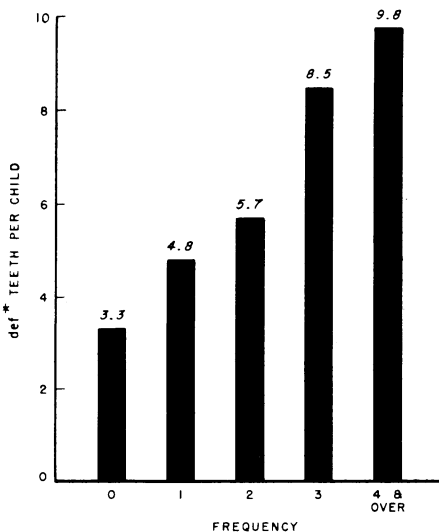
In addition to stressing the importance of good nutrition to the total health of the individual, an attempt should be made to utilize every opportunity for developing specificity in the program content of all activities aimed at discouraging undesirable eating practices as they relate to dental caries. There is every reason to believe that developing specificity in everyday communication with the public, whether it be through

direct counseling, educational activities, or information programs, will result in better programs. Program content that is clearly circumscribed, utilizing findings related to frequency of eating and caries such as presented in this report, for example, contributes to better program planning and evaluation. In contrast, program content consisting of a profusion of basic scientific facts and other details relating to the carbohydrate-caries relationship are based on an Alice in Wonderland philosophy; that is, "you are bound to get somewhere if you walk long enough." Content of this type is unwieldy and the effectiveness of an approach of this kind cannot be easily demonstrated. Also, since it appears that the items of high sugar content or those of a high degree of adhesiveness are the most popular types of between-meal items selected by children, programs aimed simply at quantitatively reducing the frequency of eating between meals might be more rewarding than programs overly concerned about the type of items consumed.

Utilizing findings such as presented in this report as a primary focus appears to be a logical beginning in determining program content. The method described in this study appears to be adaptable for

effective program evaluation. It is a relatively simple method and warrants further development as a basis for measuring changes in the between-meal eating patterns of children as related to caries experience. Also, content of this kind allows for ample individual identification, since the risks involved from excessive between-meal eating are defined explicitly. Consequently, more impetus may be generated for acceptance and action on the part of the individual or the public as a whole. Findings such as presented in this report should elicit a more desirable response from the public than generalizations such as "eliminate sweets," "reduce sugar," and "substitute fruit, popcorn, and nuts." These generalizations are difficult for the public to understand and difficult for them to apply throughout the course of everyday living. There is also reason to believe that they have become meaningless to the teacher as well as to the learner.

**Figure 2—Number of def\* Teeth, by Frequency of Between-Meal Eating, West Tennessee, 1956**



\* Includes extracted primary molars.

## Summary

A study conducted at preschool health conferences in West Tennessee was designed to determine the types of between-meal items consumed and to explore the relationship between the frequency of eating between meals and caries experience. A method based on two gross determinations, the 24-hour recall and the def score, was used.

Most items consumed between meals were items of high sugar content or of a high degree of adhesiveness. The most popular type of between-meal items consumed, in descending order of popularity, were gum, candy, soft drinks, pastries, and ice cream. No significant differences were observed in the selection of between-meal items by boys and girls or rural and town children.

The average frequency of eating between meals was 1.75 items per day—the average number of def teeth, 5.88. These figures were applicable to the total groups studied and to each of its subgroups, that is, between male and female and between town and rural children.

A direct and consistent relationship between caries experience and the frequency of eating items of high sugar content or high degree of adhesiveness between meals was disclosed. As the frequency of eating such items between meals increased, a corresponding increase was noted in the number of def teeth per child. The children who reported eating no items of this nature between meals the day prior to the health conference exhibited a def of 3.3 teeth per child in contrast to the children at the other end of the scale. Those who reported eating four or more such items between meals exhibited a def of 9.8 teeth per child.

**ACKNOWLEDGMENTS**—The study was conducted under the auspices of the Division of Dental Public Health of the Tennessee Department of Public Health. Consultative assistance was given by Frances N. Shoun, director of nutrition service, and Ann Dillon,

director of statistical services of the Tennessee Department of Public Health. Completion of this report was facilitated through assistance from Charles Broring, student assistant, Division of Dental Public Health, Public Health Service, U. S. Department of Health, Education, and Welfare.

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This paper was presented before a Joint Session of the Dental Health and Food and Nutrition Sections of the American Public Health Association at the Eighty-Seventh Annual Meeting in Atlantic City, N. J., October 20, 1959.

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## New Professional Nutrition Society

The American Society for Clinical Nutrition was founded in May and is in the process of affiliating with the American Institute for Nutrition.

Richard W. Vilter, M.D., professor of medicine and chairman of the department, University of Cincinnati College of Medicine, was elected first president. President-elect is Robert E. Olson, M.D., Ph.D., professor and head of the Department of Biochemistry and Nutrition, University of Pittsburgh Graduate School of Public Health, Pittsburgh. Robert E. Hodges, M.D., associate professor of medicine, University of Iowa School of Medicine, Iowa City, is secretary-treasurer. (The office of the secretary-treasurer will serve as ASCN headquarters.)

The four objectives of the ASCN are to: (1) Foster high standards for research on human nutrition; (2) promote undergraduate and graduate education in human nutrition; (3) provide a place and opportunity for research workers on problems of human nutrition to present and discuss their research activities and results; (4) provide a journal for the publication of meritorious work on human nutrition.